DEVELOPMENT OF INTERACTIVE PRE-COLLEGE COMPUTATIONAL SCIENCE ENRICHMENT

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The use of computational resources has slowly become a mainstay in many of today's classrooms. With vast amounts of information available at their fingertips, as well as new and innovative ways to tap into them, educators find themselves with a new tool with which to excite students and spark interest.

The University of Houston - Downtown has taken this unique resource and used it to enrich the material of junior high and high school level classes by offering a Saturday Houston PREP. This program improves the students' knowledge in mathematics and science while also exposing them to computational approaches to solving problems. It also eases the transition that will have to be made by both educators and students from conventional teaching approaches to those that incorporate both new technology and computational resources. The Saturday Houston PREP can be subdivided into two distinct parts, a Computational Science Academy and a Java Academy, each of which takes a unique approach to teaching and also utilizes computational resources.

The large portion of students in the Computational Science Academy partake in courses centered around building basic mathematics, science and computer skills, as well as refining logic and problem solving abilities. This is done by expanding key concepts from junior high and high school curriculums, and reintroducing them using either online resources or well-designed programs.

One of the tools used to develop mathematical abilities is the Plato 2000 program, which is designed to sharpen analytical mathematics skills at all levels. The format of this program allows students to first go through various tutorials, practice learned material, and then take a mastery test. In the event that a student finds material that he or she has not encountered in the classroom, the tutorials provide ample explanations of basic concepts using colorful graphics and short animation. If students fail mastery tests, they are directed to the tutorials again to clarify concepts so that mastery of the material is ensured. In general, students enjoy using this program, as it strays from the conventional use of worksheets and textbooks. The design of the program allows lessons to be taught at individual paces, so students become active learners and do not become discouraged or disinterested in the material.

To complement the use of Plato 2000, instructors are also able to utilize a wide variety of online resources to present mathematics material. Several Internet sites now host lessons that can be used to give interactive lectures to a group of students accessing the site. This combines both the teaching abilities of the instructor as well as visually appealing web pages to provide an excellent learning environment.

A source that has been used repeatedly for these lectures is the site maintained by Cynthia Lanius, at Rice University. This well designed site (http://math.rice.edu/~lanius) provides several lectures that can be either printed out or, in some cases, be interactive

through added Java applications. The design of these lectures allows for exploration by an individual student or a group of students led by an instructor. Each lecture includes additional notes to facilitate preparation of the lecture. Even though several of the lessons still require the use of printed material, this site still provides a good example of the type of resources that need to be available for instructors.

In addition to improving their mathematics background, the online resources used by the Computational Science Academy also give students a unique opportunity to explore various areas of science and technology. Utilizing online lectures at various Internet sites, instructors are able to provide activities that are both fun and educational. The most noteworthy of these sites comes from the San Diego Supercomputing Center. Links from this site contain lectures in Biology, Chemistry, Geology and Mathematics that are particularly suited for junior high and high school students. Most of these lessons are fully interactive, and can be done with minimal lecturing. A good example for this is the Virtual Frog Dissection, which allows students to explore the anatomy of a frog using vivid diagrams and interactive web pages. This type of lesson foreshadows the kind of teaching that may be part of the future educational environment - where the student controls the pace of learning and the computer is their personal instructor.

The second portion of Saturday Houston PREP, the Java Academy, focuses on learning the programming language Java. This is taught through the use of Tango Interactive, a program which allows Syracuse University to serve as a "virtual university" whereby students from distant sites can participate in online discussions and lectures. The versatility of this program allows the use of shared browsers, shared applications, chat rooms, and video conferencing, all of which can be used in concert to allow students to actively participate in the virtual classrooms.

In addition to providing students with a unique opportunity to attend these classes, the Java Academy also sparked interest in the technology which provided the lectures. Robert Shankin of CCSDS, one of the instructors for the Java Academy, said that students "were quite stimulated by the instant visual feedback from the computer and the sense of
accomplishment in developing content-rich programs. These students also got the opportunity to sample the challenging type of activity they will soon encounter in college."

The classes themselves consisted of short lectures, followed by lab exercises. During these exercises, students were shown a working Java program, and instructed to add features or make large-scale changes. Some of these included working with GUI interface components, creating or editing a simple calculator, creating a simple tic-tac-toe game, and displaying simple animation. Following the completion of the lab exercises, students created links to their applets from personal web pages. The use of personal web pages was particularly appealing to students, as it taught them presentation skills and organization of ideas. However, such a medium for expression does not have to remain a part of only computer science presentations. Our future mathematics and science Saturday Houston PREP classes may include lectures in which similar web-based presentations are required of students.

Upon completing this year's course, the students in both sections were given an in-depth survey. The main goal of this survey was to ascertain their current strengths and weaknesses as they relate to science, mathematics, and computer science, and whether

the Saturday Houston PREP strengthened theirs skills in these areas. The results of these surveys are detailed in figures 1 – 4. The first part of the survey asked students to state whether they preferred conventional teaching techniques or computer aided learning (Fig 1). While most students preferred and enjoyed the computer-based lessons, many students felt that there was still a need for lessons guided by instructors or those supplemented with oral discussion. This leaves room for improvement within current online and computer-based lessons in order to fulfill the needs of these students.

The majority of the students from the Computational Science Academy were very pleased with the lectures that were given, as they reinforced their understanding of basic concepts introduced during the school year. In particular, the students were very impressed with the manner in which the lectures were taught, and expressed an interest in having more exposure to online and computational resources. To further elaborate on this, students were asked questions concerning their exposure to computers in general during the school year (Fig 2). Most students had minimal exposure, and had not even considered using online resources such as those harnessed in the Saturday Houston PREP. In addition, students were also asked to specifically evaluate their mathematical skills before and after using the PLATO 2000 computer program (Fig 3). Most students felt that they had improved both mechanical and problem solving skills through the use of this program.

Students that had attended the Java Academy had similar responses, except that all were eager to further explore computational resources. The added exposure to the power of collaborative learning through the use of a "virtual university" had most likely excited them about such approaches and given them the confidence to take the next steps in their education (Fig 3). In addition most of the students that had remained for the duration of the Java Academy had been those with extensive computer exposure within their schools. To help alleviate this deficiency in the knowledge of some students, the Java Academy will be expanded to ease younger and less computer-proficient students into the Java classes. Students will first spend a year learning basic computer skills and the programming language C++. However, it stands to reason that if such programs are to work, the first step must be taken in the schools to prepare students for these exciting opportunities.

The format for the Saturday Houston PREP sets a precedent for the type of educational program that must become an integral part of junior high and high school curriculums. This is demonstrated by the initiative taken by the state of Florida in their virtual high school project in collaboration with IBM. While providing enrichment material above and beyond that which is necessary, the Saturday Houston PREP classes still demonstrate the potential uses of the Internet and computational resources in getting students excited about material in any subject area. The goal of any educator should be to get students excited in their material, since this will lead to better retention and a desire to understand what is being taught. With that in mind, it will become necessary to start training educators immediately to take advantage of this largely unused, and powerful, resource.

The future for the Saturday Houston PREP lies in the continued efforts to promote awareness of computational resources. This will come with greater usage of these resources, as well as carefully monitored progress through the establishment of

benchmarks. This effort will allow others to use the Saturday Houston PREP as a standard by which to modernize our educational tools.